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Indian Standard

GUIDE FOR TESTING, CALIBRATION AND MAINTENANCE OF ac ELECTRICITY METERS

PART 1 SINGLE PHASE WHOLE CURRENT WATTHOUR METERS, CLASS 2·0

(First Revision)

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July 1988

Indian Standard

GUIDE FOR TESTING, CALIBRATION AND MAINTENANCE OF ac ELECTRICITY METERS

PART 1 SINGLE PHASE WHOLE CURRENT WATTHOUR METERS, CLASS 2·0

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards on 22 October 1987, after the draft finalized by the Integrating Meters Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This Indian Standard (Part 1) was published in 1981, and is revised to incorporate modifications and test methods as also requirements of lubricating oil for bearings.

0.3 Proper testing, calibration, installation and maintenance of electricity meters is of vital importance to ensure that meters comply with the specified limits of errors and give reliable performance during their use. This revised guide would give the necessary guidance to the users regarding the methods of testing, calibration and maintenance of electricity meters.

0.4 It is intended to publish this guide in different parts for different types of meters such as single phase watthour meters, polyphase watthour meters, etc. This guide for single phase watthour meters forms Part 1 of the series.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This guide (Part 1) covers procedure for testing, calibration and maintenance of single phase whole current watt meters for Class 2 complying with IS : 722 (Part 2)-1977*.

1.2 This guide does not cover installation of meters.

2. TERMINOLOGY

2.1 For the purpose of this guide, the following definition in addition to the definitions given in IS : 722 (Part 1)-1986†, shall apply.

2.2 Phantom Loading — The method of loading, the meter in which voltage circuits and current circuits are supplied from two separate circuits; the voltage circuit is supplied at rated voltage and rated frequency, and the current circuit is generally supplied at reduced voltage and rated frequency. The phase angle between the two circuits is adjustable through the phase-shifter.

3. GENERAL

3.1 For the purpose of this guide, the provisions of the *Indian Electricity Act, 1910* and the *Indian Electricity Rules, 1956* made thereunder and amended from time to time shall be applicable.

3.1.1 Particular attention is drawn to Section 26 of the *Indian Electricity Act* and Rules 56 and 57 of the *Indian Electricity Rules.*

4. INSPECTION

4.0 General — The inspection and tests shall be carried out according to the sequence given in this guide.

4.1 It is recommended that the meters are despatched from the factory generally packed in polythene bags and placed in corrugated cardboard cartons. The meter is further protected by the placement of corrugated sheet packings or similar other materials. The filled cartons are, in turn, placed in suitable containers capable of withstanding transit shocks.

The meters are arranged in layers within the container. In between the layers and between the side of container and layer, suitable packing, such as grass, wool, thermocole material or paper cuttings is also provided.

4.2 Meters are liable to get damaged during transport. It is, therefore, recommended that, after receipt of the consignment of meters, the boxes are examined for any external damage due to handling, seepage of water, etc.

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*Specification for ac electricity meters: Part 2 Single phase whole current watthour meters, Class 2 (*first revision*).

†Specification for ac electricity meters: Part 1 General requirements and tests (*third revision*).

4.3 The meter boxes should then be carefully opened to check if the meters in the cartons are received in good condition. Each meter should be examined externally; particular attention should be paid to window glass, meter case, fixing clamps and terminal block. The meter should also be examined for any missing components, such as terminal cover, connection screws, sealing screws and earthing screws.

4.4 The meter case shall also be examined for formation of rust and condition of paint.

4.5 The meters should then be gently shaken to find out if there are any loose components inside.

5. STORAGE

5.1 The meters, after inspection, shall be placed in cartons and stored in a clean and dry place.

5.2 The store room chosen for such storage should be free from dust, corrosive gases and excessive moisture.

5.3 The meters shall be stored on raised racks to prevent damage due to vermin. It is recommended that periodic inspection be carried out for signs of damage due to vermin.

6. PRELIMINARY EXAMINATION AND TESTS

6.1 Examination of Meter Components — The meter cover shall be opened and any packing piece provided to block the rotor movement shall be removed and the internal components shall then be examined.

6.1.1 Components likely to be damaged in transit are window glass, mounting bracket, terminal block, disc and spindle, bearing assembly, register assembly, and brake magnet. These components shall be examined to ascertain loose connections, loose fittings and deformation.

NOTE — Loose current electromagnet assembly or voltage electromagnet assembly would give erratic test results. Loose connections are also likely to result in erroneous registration of energy.

6.1.2 The connection observed to be loose shall be tightened to ensure good electrical contact. Loosely fixed components shall be rigidly re-fixed.

6.1.3 The meter components should be cleaned to remove dust and metallic particles. All parts should be cleaned with a soft brush or by blowing compressed air free from moisture (preferably at a pressure of 170 kPa). However, care should be taken to ensure that disc and spindle are not damaged by the blowing of compressed air. The air gap of the brake magnet should then be cleaned by a non-magnetic strip to remove particles sticking to the magnet.

6.2 Continuity Test — Continuity of current and voltage circuits is checked by a suitable instrument.

6.3 Insulation Resistance Test — The test shall be carried out in accordance with IS : 722 (Part 1)-1986*.

7. PREPARATION OF PRE-TEST RECORDS

7.1 Meters to be tested for calibration and adjustment shall be allotted the user's serial number. The record of serial numbers shall be maintained by preparing meter test record cards and/or in an inventory register. The details of the meter test record card and the form of the register may be as shown in the proforma given in Appendix A. It shall be ensured that meter serial number allotted as above, is correctly stencilled or printed on the meter.

8. METHODS OF CALIBRATION

8.0 For the purpose of calibration of meters, the testing stations should be equipped with phantom loading arrangement. The current and voltage circuits of the meter are required to be separated by opening the voltage disconnecting link.

8.1 The methods of calibrating single phase meters are as follows:

a) Wattmeter and stop watch method,

b) Rotating sub-standard (RSS) meter method, and

c) Pilot meter method.

The current circuits of all the meters under test and the current circuit of the wattmeter/rotating sub-standard meter/pilot meter are connected in series to the current terminals of the test bench. The voltage circuits are connected in parallel to the potential terminals of the test bench.

8.1.1 *Wattmeter and Stop Watch Method* — The load in watts passing through the meter is held constant at a pre-determined value by continuously regulating voltage or current passing through the meter. The correct number of seconds required for a pre-determined number of revolutions of meter disc, generally not less than 10 revolutions, is calculated. The number of seconds actually taken to complete the number of revolutions is then measured. The difference in the time (that is, correct time and actual time) should give the error of the meter, and shall be used to determine the percentage error as given below:

$$\text{Percentage error} = \frac{T - t}{t} \times 100$$

where

t = actual time (or time as observed) taken for a given number of revolutions; and

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*Specification for ac electricity meters: Part 1 General requirements and tests (*third revision*).

T = correct time, or the time a correct meter would require for the same number of revolutions of the rotor.

Inherent errors of the precision grade wattmeter shall be compounded with the error calculated above.

The measurement of time is done by a suitable stop watch or chronometer.

The precision grade wattmeter shall be of a class index 0·5 or better. The wattmeter shall be periodically calibrated against the laboratory standard of a class index 0·2 or better. The chronometer/stop watch shall also be periodically calibrated and adjusted against a suitable time standard such as master clock or vibrograph.

8.1.2 *Rotating Sub-standard (RSS) Meter Method* — Calibration is done by the comparison of revolutions of the meter under test with those of the rotating sub-standard (RSS) meter. Generally, 10 revolutions of a meter under test is revolutions taken.

The rev/kWh for the RSS meter and those for the meters under test may not be the same. In that event, the equivalent revolutions of the RSS meter is required to be first calculated; say for instance, the constant of a meter under test is 600 rev/kWh and that of RSS meter 1 200 rev/kWh, then for 10 revolutions of the meter will be equivalent to 20 revolutions of the RSS meter. The actual revolutions, the RSS meter makes for 10 complete revolutions of meter under test, are read on the dial of the RSS meter.

The percentage error is calculated as follows:

$$\text{Percentage error} = \frac{\text{Ideal revolutions of RSS meter} - \text{Actual revolutions of RSS meter}}{\text{Actual revolutions of RSS meter}} \times 100$$

Alternatively, the number of revolutions completed by the meters under test for a fixed number of revolutions of the RSS meter is observed by adjusting zero marks of the discs of the meters under test, and the error is calculated by noting the difference between the actual number of revolutions and the ideal revolutions required to be completed. The graduations provided on the disc are used for the purpose. The testing by this method should be done in rooms where the flow of air does not affect the rotation of the disc of the meter under test.

The percentage error is calculated as follows:

$$\text{Percentage error} = \frac{\text{Actual revolutions of meter under test} - \text{Ideal revolutions of meter under test}}{\text{Ideal revolutions of meter under test}} \times 100$$

The inherent error of the RSS meter shall be compounded with the error calculated above.

8.1.3 *Pilot Meter Method* — A meter of the same type, rating and constant as the test meter is choosen as a pilot meter. The pilot meter is correctly adjusted and calibrated to ascertain that its errors are well within the limits stipulated in IS : 722 (Part 2)-1977*. This pilot meter is then connected in series with the meter under test and used as a reference standard. Revolution tests are taken at the various test points required and meter under test are adjusted to conform as far as possible (within a variation of ±0·2 percent) to the pilot meter. The error at various load points can be had by compounding the above difference with the error of the pilot meter.

9. TESTS AND ADJUSTMENTS CARRIED OUT IN SEQUENCE WHILE CALIBRATING METERS

9.1 Preparation for Tests

9.1.1 The meters under test and the wattmeter/RSS meter/pilot meter are connected as stated in **8.1** on a test bench. The voltage circuit of the bench shall be switched on and the voltage shall be adjusted to the reference voltage. This voltage shall be kept on for at least 30 min to warm up the voltage coils of the meter before conducting any test.

9.1.2 The meter shall be examined to check that rotor movement is free, that there is no iron filings, etc, in the brake magnet and driving element gaps, and that there is no dirt or dust on the disc.

9.1.3 Before determination of actual errors of meters under test, it is advantageous to adjust low load adjustments to prevent creeping of the meter and inductive load adjustment to bring the rotor to rest at zero power factor.

9.2 Limits of Errors

9.2.1 *Limits of Error at Basic Current, Unity Power Factor*

9.2.1.1 The voltage shall be adjusted to reference voltage, and current shall be adjusted to basic current at unity power factor.

9.2.1.2 The calibration shall be done by one of the methods specified in **8.1** and percentage error shall be calculated.

9.2.1.3 Meter shall be adjusted by brake magnet adjustment to bring error within the specified limits of IS : 722 (Part 2)-1977*.

9.2.1.4 If the meter cannot be brought within the limits of errors of IS : 722 (Part 2)-1977* by adjustment, the meter shall be rejected.

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*Specification for ac electricity meters: Part 2 Single phase whole current watthour meters, Class 2 (*first revision*).

9.2.1.5 All the meters shall be tested at basic current, unity power factor after adjustments before proceeding further.

9.2.2 *Limits of Error at Basic Current, Power Factor = 0·5 lag*

9.2.2.1 The voltage shall be adjusted to reference voltage.

9.2.2.2 Current shall be adjusted to basic current at 0·5 power factor lagging.

9.2.2.3 All the meters shall be tested by one of the methods specified in **8.1** and percentage error shall be calculated.

9.2.2.4 Meter shall be adjusted on inductive load adjustment if it is not within the specified limits of error of IS : 722 (Part 2)-1977*.

9.2.2.5 If the meter cannot be brought within the specified limits of errors of IS : 722 (Part 2)-1977* by adjustment, the meter shall be rejected.

9.2.3 *Limits of Error at 5 Percent Basic Current, Unity Power Factor*

9.2.3.1 The voltage shall be adjusted to reference voltage.

9.2.3.2 Current shall be adjusted to 5 percent of basic current at unity power factor.

9.2.3.3 All the meters shall be tested by one of the methods given under **8.1** and percentage error shall be calculated.

9.2.3.4 Meter shall be adjusted on low load adjustment if it is not within the specified limits of error of IS : 722 (Part 2)-1977*.

9.2.3.5 If the meter cannot be brought within the specified limits of error of IS : 722 (Part 2)-1977*, the meter shall be rejected.

9.2.4 *Limits of Error at I_{Max}, Unity Power Factor*

9.2.4.1 The voltage shall be adjusted to reference voltage.

9.2.4.2 The current shall be adjusted to I_{Max} at unity power factor.

9.2.4.3 All the meter shall be tested by one of the methods specified in **8.1** and percentage error shall be calculated.

9.2.4.4 If the meter is not within the specified limits of error of IS : 722 (Part 2)-1977* the meter shall be rejected.

9.2.5 In the case of the meters rejected at **9.2.2.5** and/or **9.2.3.5** and/or **9.2.4.4**, suitable adjustment may be made in the brake magnet to bring the errors, if possible, within the specified limits at all the four points. Even after this adjustment, if at any of the four points the errors are beyond the specified limits, the meter shall be rejected.

9.3 Starting

9.3.1 The test shall be done in accordance with the provisions laid down in IS : 722 (Part 1)-1986*.

9.4 Running With No Load

9.4.1 The test shall be done in accordance with the provisions laid down in IS : 722 (Part 1)-1986*.

9.4.2 If the disc continues to revolve beyond one revolution, meter may be adjusted on anticreep adjustment, if any.

9.4.3 If the meter is not provided with anticreep adjustment, it may be adjusted on low load and such meters shall be checked again for starting current and low load error.

10. DIAL TEST

10.1 The voltage shall be adjusted to reference voltage.

10.2 Current shall be adjusted to I_{Max} unity power factor.

10.3 All the meters shall be subjected to dial test simultaneously.

10.4 Reading of RSS meter and the meters under test shall be noted before starting dial test.

10.5 At least one revolution of the fastest moving drum/pointer shall be completed.

10.6 Percentage error shall be calculated by the following formula:

$$\text{Percentage error} = \frac{(R_a - R_1) - K}{K} \times 100$$

where

R_a = final reading of meter under test,
R_1 = initial reading of meter under test, and
K = number of kWh recorded on RSS meter.

10.7 Meter is slow if it registers less than K and is fast if it registers more than K.

10.8 A dial test conducted for a short period is not a reliable test for determining the error since reading error would be appreciable in small registrations. Meters having errors beyond the limits specified in IS : 722 (Part 2)-1977† shall be subjected to dial test of longer period of not less than 2 h to minimize the effect of reading error.

10.9 Meters shall be rejected if the percentage error in the long duration dial test is not within the specified limits of errors of IS : 722 (Part 2)-1977†.

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*Specification for ac electricity meters: Part 2 Single phase whole current watthour meters, Class 2 (*first revision*).

*Specification for ac electricity meters: Part 1 General requirements and tests (*third revision*).

†Specification for ac electricity meters: Part 2 Single phase whole current watthour meters, Class 2 (*first revision*).

10.10 Measurement of Potential Circuit Power Loss

10.10.1 *Description of Operation of the Circuit Diagram*

a) *Vaccum tube multiplier method (see Fig. 1)* — This tester is a vaccum tube power meter with twin triode, and the voltage with 180° phase shift is added on both plates in twin triode and also input voltage which is changed by the impedance (Z_p) of a test piece is added on the control grid.

Multiplication of *EP Eg* is done by the non-linearity of control grid volt-plate current in the triode tube and is indicated on the scales of the micro-ammeter.

The circuit diagram of the tester is given in Fig. 1. The test piece leads are to be introduced at the terminals provided where the rated voltage will develop by the internal circuitary. Instrument is calibrated to read 1·0 W initially and the selector switch will be put into 'test' and measurements to be made.

b) *By using ac coordinate potentiometer* — By employing polar coordinate type potentiometer, power loss in the potential circuit can be measured. The current magnitude and the phase angle by changing over the *VA* selector of potentiometer and calculations are made as follows:

$$R = \frac{V}{I} \cos \theta$$

$$X = \frac{V}{I} \sin \theta$$

$$\text{Apparent power} = (\text{Rated voltage})^2 \times \frac{I}{V}$$

Power

$$\text{loss} = (\text{Rated voltage})^2 \times \frac{I}{V} \times \cos \theta$$

c) *By employing low power factor meters* — Low *PF* wattmeters of power factor 0·1 to 0·2 is to be used. The range shall be such that the measured value is not less than 30 percent of full scale division. For the measurement of power loss of the potential circuit of a kWh meter, the excitation current drawn by the coil will be connected to current terminals and pressure applied between the terminals of the coil is to be connected to the voltage terminals. The value of power consumed by the coil can be read directly.

d) *Digital VAW meters* — Watt loss can also be measured by ac digital VAW meters.

10.11 Measurement of Driving Torque of an Energy Meter — The apparatus and set-up used for the measurement of driving torque of energy meter is shown in Fig. 2. A string with a known weight tied at one end is supported at point A. The string is preferably of unspun silk. The levelling screws are adjusted such that the string is truly vertical.

A weight *W* is tied to the end of a silk string suspended at A on the stand. At B, at a distance of 1 000 mm from A, another silk

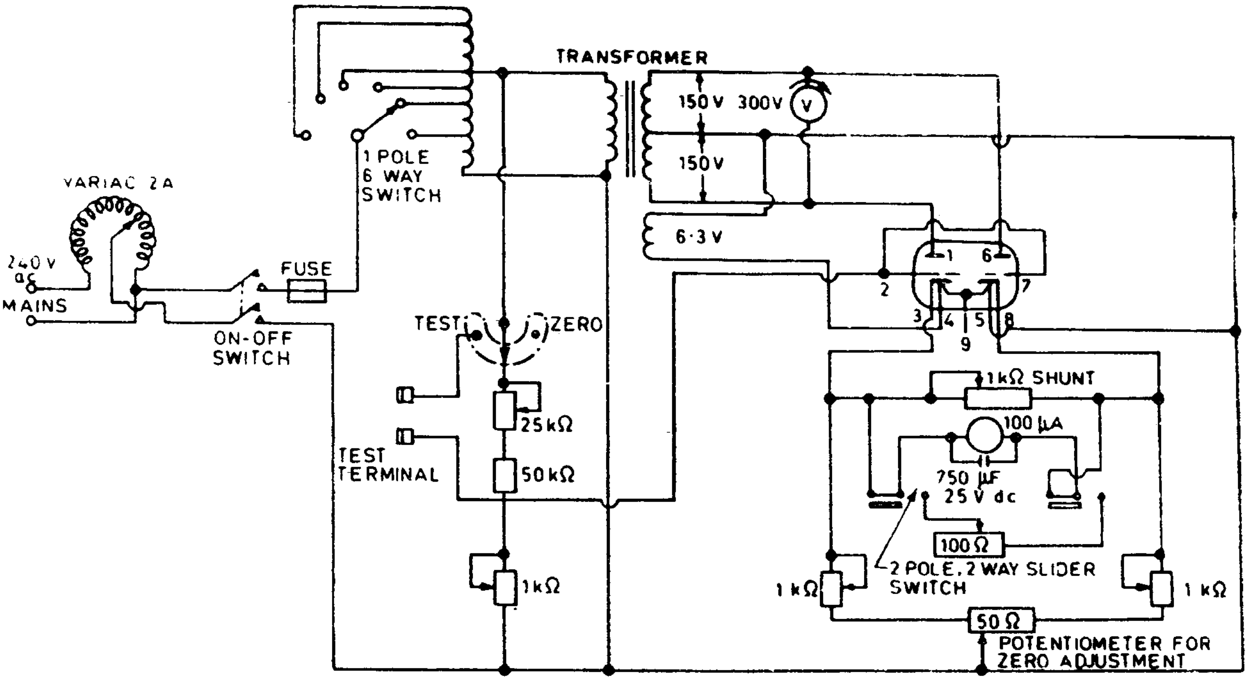


FIG. 1 POTENTIAL CIRCUIT POWER LOSS TESTER

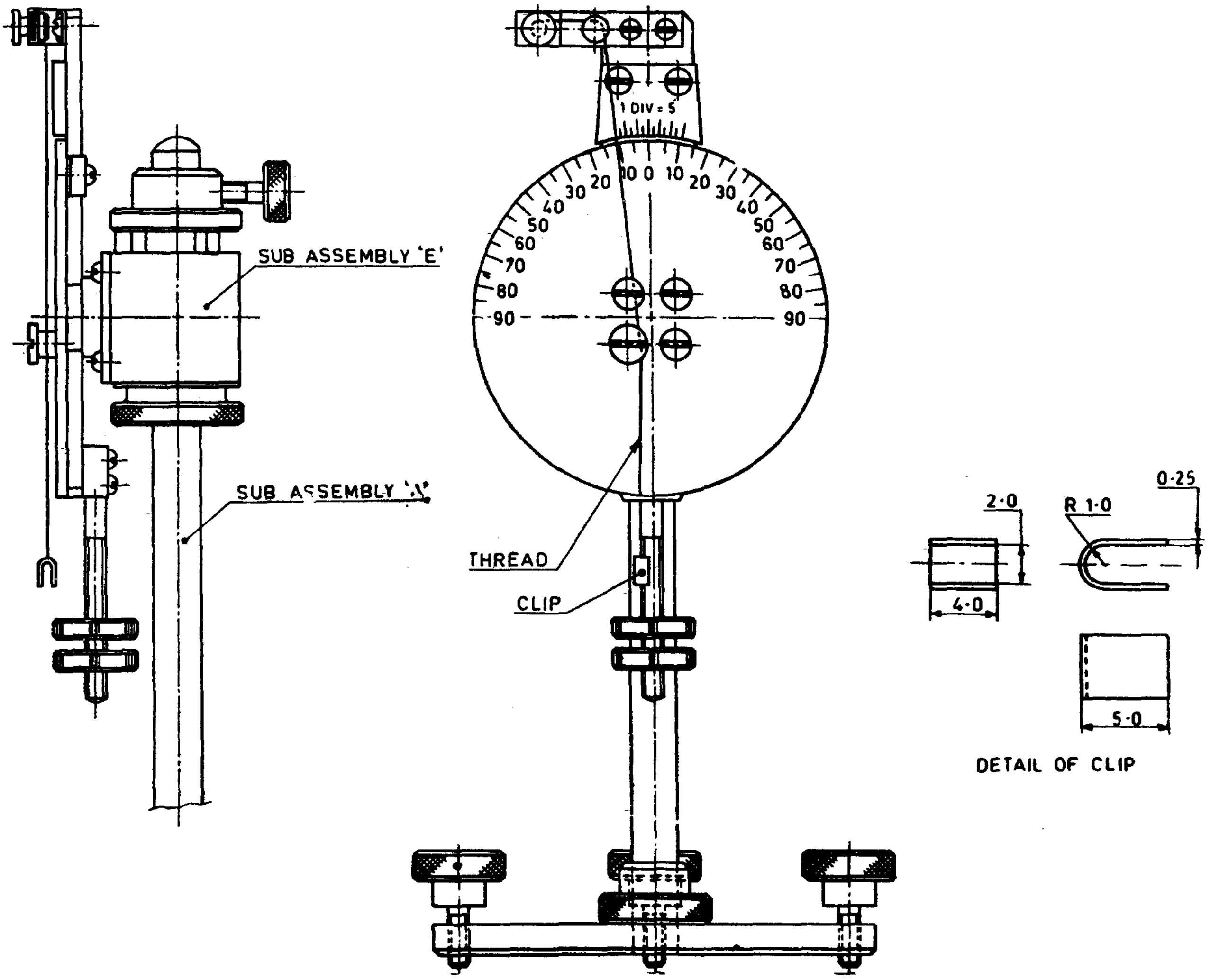


FIG. 2 TORQUE METER

string is tied to the main string. The other end of the string is tied to the creep holes of the disc of the meter under test and a loop knot is tied at the periphery of the disc. The distance between B and C (point of knot) must be such as to hold the string BC a little tight and BC must be horizontal. Now supply the basic load and apply normal pressure to the meter coil, since it is prevented from revolving, pulls BC and the weight occupies a different position. Now, adjust the position of the stand such that BC is exactly tangential to the disc and the distance between the string and the scale is about 2·5 mm and the scale is parallel to BC. Now, note the reading *d* on the scale. Remove the loop knot which had been tied at C, between string BC and the disc. The weight and hence the string AB will occupy a stable position E on the scale. Note the reading E on the scale. Determine the distance DE and call it *d*. The strings from A to B, B to disc and B to the weight *W* shall all be in the same plane.

Calculations — Referring to Fig. 2.

$$\tan\theta = \frac{F}{W} = \frac{d}{L}$$

$$F = W \times \frac{d}{L}$$

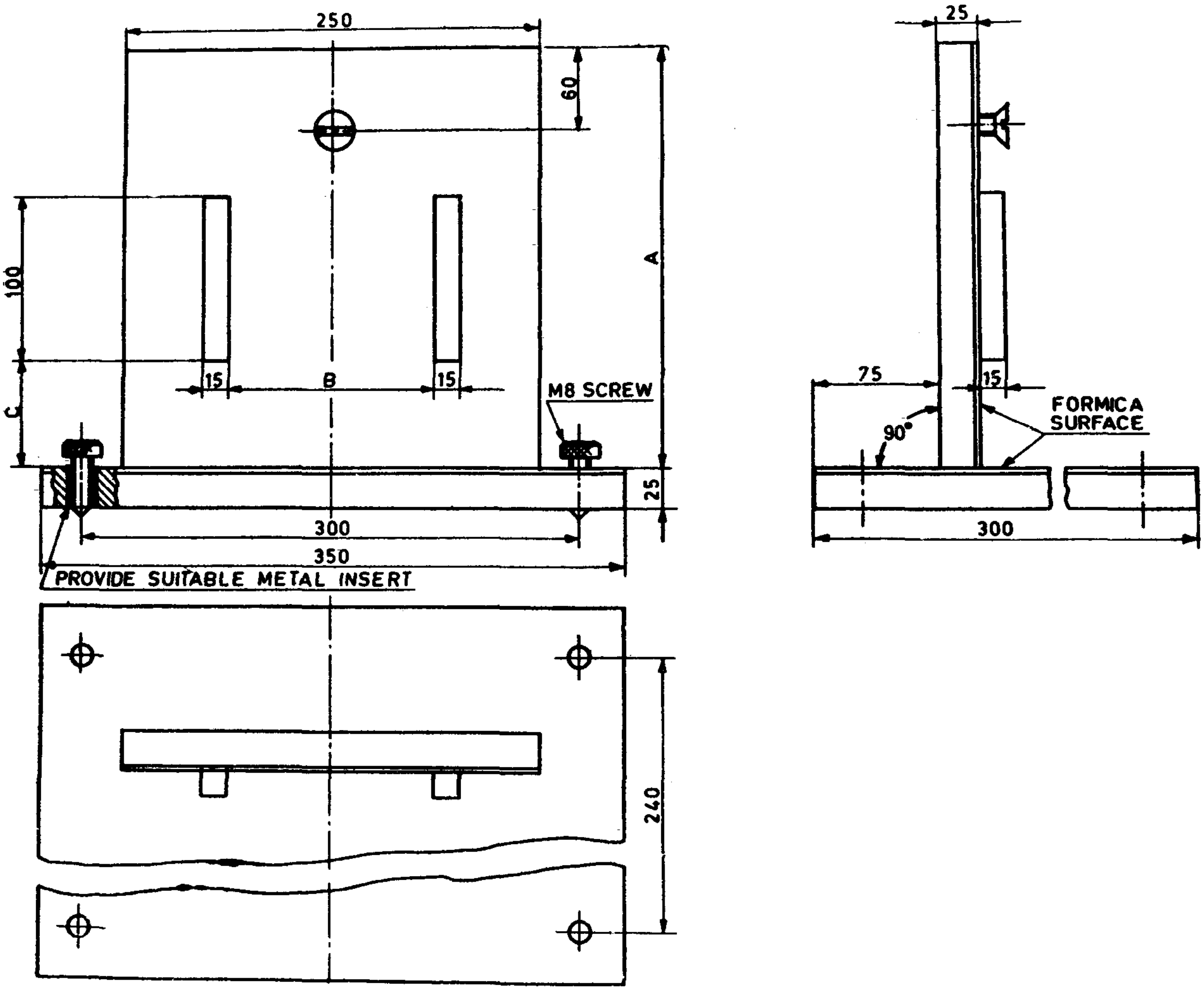
$$\text{Torque} = F \times r = W \times \frac{d}{L} \times r \text{ g.mm}$$

where r is the radius of rotor in mm.

10.12 Method of Measuring the Influence Due to Oblique Suspension — The test jig employed for conducting this test is similar to the one as shown in Fig. 3.

Meter is energized from the phantom loading source at its appropriate terminals, applying voltage across the voltage terminals and the rated current made to flow throughout the current circuit. Percentage error is computed at loads specified in individual parts, of IS : 722 at different positions of the plane (front, back, left and right). Different obliguites are obtained by adjusting bottom screws with reference to a spirit level and plumb line.

10.13 Method of Measuring the Effect of Short Circuits — This may be obtained from either capacitor discharge or thyristor control of the



Dimension *A*	Dimension *B*	Dimension *C*
400	136·5	180
280	109·5	105

All dimensions in millimetres.

FIG. 3 TEST JIG FOR MEASURING THE INFLUENCE DUE TO OBLIQUE SUSPENSION

mains supply. The test circuit shall be practically non-inductive. Alternatively, the test current may be obtained from a low voltage high current source capable of withstanding burden of current circuit of polyphase meters up to 100 A rating. A time switch of suitable timing capacity to switch off the load after 0·5 seconds of application may be connected in series with low voltage winding of transfer to control the current.

10.14 Method of Measuring the Influence of External Magnetic Field — The test consists of:

a) *For a Single-Phase Meter* — Determining the errors at first with the meter normally connected to the mains and then after inverting the connections to the current circuits as well as to the voltage circuits. Half of the difference between the two errors is the value of the variation of error. Because of the unknown phase of the external field, the test has to be made at 0·1 I_b at cos ϕ (or sin ϕ) = 1, as applicable, and 0·2 I_b at 0·5 power factor.

b) *For a Three-Phase Meter* — Making three measurements, at 0·1 I_b at cos ϕ (or sin ϕ) = 1, as applicable after each of which the connections to the current circuits and to the voltage circuits are changed over to 120°, while the phase sequence is not altered. The greatest difference between each of the errors so determined and their average value is the value of the variation of error.

10.15 Calibration of Meter Using Electronic Counting Device — Meter calibration is done by employing any of the conventional methods described in **8.1**. In addition to this, one more latest technique namely, calibration by electronic counting method is also available as described below.

This method may be employed where facilities, such as opto sensors, standard pulse generators and other associated aids are available at the testing laboratory.

The measuring process begins as soon as the first impulse from the test meter has been scanned. This can be taken from the calibration mark on the rotor of an induction meter or from the light diode of retransmitting contact of a solid state precision meter. The first impulse from the test meter is not registered since this is used to open the gate for the counting of the reference impulses from the built-in quartz or the external reference standard. The impulses are registered in reference pulse counter. These reference impulses are fed simultaneously to the digital indicator, the test meter impulses are fed to the 4 digit counting register via an input circuit.

The percentage error is either directly displayed or calculated based on the formula:

$$F = \frac{t_8 - t_1}{t_1} \times 100$$

where

t_8 = nominal time or number of reference impulses, and

t_1 = measured time or number of actual impulses.

10.15.1 *Measured Value Indicator* — The measuring process likewise begins as soon as the first impulse from the test meter has been scanned. This impulse is not registered since this is used to open the gate for the counting of reference pulses into the 6 digit counting register as well as into the respective digital indicator. The reference impulse sequence is interrupted as soon as this is counted in test meter impulses corresponding with the pre-selected value. The percentage error, directly as computed by the differentiator, is displayed on the digital display placed in front of each meter under test.

10.16 Testing on Cyclometer Type Registering Mechanism — Following are the tests to be conducted on the cyclometer type registering mechanism to ascertain its suitability in the watthour meters.

10.16.1 *Physical Check* — Check for any hard movement in the digit wheels, transfer pinions or in the gear system including the worm wheel.

10.16.2 *Dial Test at 99999 Postion* — Set the register at 99999 and energize the meter with 10 percent of the basic current with rated voltage and check whether transfer of digits take place. If digits are not transfered, once again check the registering mechanism for conformity to **10.16.1** as above.

10.16.3 *Measurement of Frictional Retardation Torque Contributed by Register Alone* — Following procedure may be adopted for measuring the frictional retardation torque offered by registering mechanism.

a) Brake magnet and register of the meter are to be removed;

b) A gentle hand push to rotor is given and cover is to be repositioned;

c) At some intermediate stage, start counting number of revolutions of the rotor till the rotor comes to stand still. Compute the time in seconds with an accurate stop, watch;

d) Calculate the mass moment of inertia of the rotor by the formula:

$$I\,(\text{kg.m}^2) = \tfrac{1}{2}\,mr^2$$

where m is the rotor weight in kg and r is the radius of the rotor in metres;

e) Frictional torque of the bearing alone is given by:

$$X_1\,(\text{N.m}) = \frac{4\pi NI}{t^2} \times 10^{-7}$$

where N is number of rotor revolutions in time t;

f) With register put into the meter, the same measurements for frictional torque are to be done. Let it be X_2;

g) Difference ($X_2 - X_1$) will give the frictional torque contributed by register alone; and

h) This value will vary from ratio gear to ratio gear and the typical value will be 20×10^{-7} Nm.

This figure will also vary with different worm wheel materials, different gear materials, different digit wheels and pinions.

11. RECORD OF TEST RESULTS

11.1 All the test results shall be entered in the meter test record card (*see* Appendix A).

12. MAINTENANCE OF ENERGY METERS

12.1 Accoroding to the provisions of *Indian Eletricity Act, 1910* and the Rules framed thereunder, the licensee is required to test every meter periodically. The periodicity of testing is fixed by the respective State Governments.

The meters are tested and calibrated in the laboratory. In order that the accuracy of the meter is maintained, utmost care is essential in handling and transportation of meters to and from the site of installation.

12.1.1 *Storage, Handling and Transportation* — Upright position of meter helps to retain the oil and prevent damage to the bearing and pivot. The meters are generally provided with handles and they shall be carried in an upright position. They shall be stored preferably in an upright position.

12.1.2 For the purpose of transport in the laboratory, trucks or trolleys designed to hold the meters in an upright position should be used.

12.1.3 The meters shall be protected from shock while transporting them from storage to site. Baskets or trays divided into compartments and lined with sponge rubber may be used. Card board cartons may also be used for transporting meters in bulk. The vehicle used for transporting meters shall be provided with shock-absorbing arrangement.

12.2 For retaining the accuracy, the meters should be installed at locations which are free from dust, vermin, moisture and vibration. The meter shall also be installed in an upright position as provided under **8.1.5** of IS : 722 (Part 1)-1986*.

12.2.1 The meter case and terminal cover shall be sealed to prevent tampering. The meter may also be provided with suitable enclosure to prevent unauthorized access and damage to the meter.

12.3 In order to comply with the statutory obligations, the meters are required to be tested for accuracy within the specified period. They could be tested either at site or by removing and bringing them to the laboratory.

12.3.1 *Site Testing* — Testing of meters at site may be done by using a phantom load test box. The loading box and rotating sub-standard are connected to the meter. Improvised loading boxes with lamp loads may also be used for testing. The loading box can be designed for L.P.F. by using lamp loads or resistors. Suitable combination of inductances and resistors can be used for other power factors.

12.3.1.1 The accuracy of the meter is ascertained by counting the revolutions of the disc of the meter under test and comparing the same with revolutions of the RSS for various loads.

12.3.1.2 The errors of the meter under test at various loads shall be calculated by the method given under **8.1.2**. The observed test results are noted and recorded on the meter history card.

12.3.1.3 The meters found beyond the permissible limits of error shall be removed and brought to laboratory for overhauling and adjustment.

12.3.2 *Laboratory Testing* — In this method, the meters are removed from installations and transported to laboratory. The handling and transportation of the meter from site to the laboratory should be done with utmost care to ensure that the conditions of the meter are not altered.

12.3.2.1 The meters shall be connected on the testing station and tested by one of the methods specified in **8.1**. The observed test results are noted and recorded on the meter history card, as incoming test results.

12.3.3 *Overhauling* — The meter brought to the laboratory shall be examined before overhauling to ascertain the signs of damages, if any. If the meter is found damaged, a list of parts requiring replacement is made.

12.3.3.1 *Dismantling* — The meter cover is opened and the connections of the elements to the terminals are removed. The assembly of elements, register and the bearing together with main frame is removed. The terminal block is also separated from the base.

12.3.3.2 The meter cover and the base are sent to the paint shop for cleaning and painting. The details of painting and cleaning process are given in Appendix B.

12.3.3.3 The register, the top and bottom bearings, and the rotor are detached from the main frame. The driving and braking elements are then cleaned by blowing compressed air or blowing air by bellows. They are further cleaned by a soft brush.

12.3.3.4 The insulation of voltage and current coils is checked at 500 V dc. The continuity of the pressure coil is also checked by a suitable instrument.

12.3.3.5 The register assembly is cleaned with a soft brush and a suitable solvent. The air gaps of driving and braking elements are then cleaned by blow of compressed air. The reading of the register is set to zero. Solvents likely to effect the material or figure of the register should be avoided. Ultrasonic baths may also be used.

12.3.3.6 The jewels are cleaned and then examined, preferably by a high grade binocular microscope having magnification of 40 to 80. The rough and cracked jewels are replaced.

The bottom pivots are of hemispherical shape. The pivot, when examined under a microscope, should show no evidence of departure from the hemispherical shape and its polished surface should be free from scratches and signs of corrosion. The top and bottom bearings are lightly lubricated with chronometer oil as given in Appendix C.

NOTE — Jewels are normally cleaned by ultrasonic method or dipping in baths containing trichloroethylene or equivalent chemical.

12.3.3.7 The rotor and its worm are cleaned by a soft brush, preferably with petrol and brush. The rotor is then checked for its trueness. The gap between the poles of the magnet is cleaned by feather. The iron dust particles are then removed by a wooden or non-magnetic strip.

12.3.4 *Assembly* — The meter is assembled. All the screws and connections are checked for tightness. The rotor is checked for its free movement in the air gap. The meter is again tested for insulation and continuity of the voltage and current circuit.

12.3.4.1 After fixing the register, the meshing and alignment of the worm and worm wheel is checked. The meter is then checked for working with a lamp load.

12.3.4.2 The serial number of the undertaking is stencilled and the meter is sent for testing and calibration.

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*Specification for ac electricity meters: Part 1 General requirements and tests (*second revision*).

APPENDIX A

(*Clauses* 7.1 *and* 11.1)

TYPICAL PROFORMA FOR METER TEST RECORD CARD

USER'S NAME

METER RECORD

Amp..........................Type and Name.............................User's No. ....

Volts.....................Frequency.................Rev/kWh................Manufacturer's No. ....

Date Tested	Accuracy at Loads				Starts on Current	Running with No Load	Reading Before Test	IR to Case (*M*)	Reading After Test	Tested By	Date Issued	Date Returned	Remarks
	Power factor 1·0			0·5 Lag									
	I_{Max}	I_b	5% I_b	I_b									

APPENDIX B

(*Clause* 12.3.3.2)

PAINTING AND CLEANING OF METERS

B-1. The rust from the outer surface of the meter covers and bases are removed on a buffing machine and the inner surface is cleaned with sand paper.

B-2. Most of the meter bases and covers are painted by dipping or spray painting process. The window glasses are pasted with pieces of wet papers on both the sides. The meter bases and covers are either dip painted of spray painted in a paint bath which consists of stoving quick drying enamel black paint mixed with a sufficient quantity of thinner, so that the viscosity of the paint is adjusted between 20 and 30 flow-seconds with 'flow-up' viscometer cup No. 4.

B-3. The meter covers and bases are taken out from the paint bath and kept on the rack for dripping of excess paint. The meter bases and covers are baked for 20 minutes in an oven, the temperature of which is normally 120°C.

B-4. In certain cases, where the brake magnets are fixed permanently to the meter bases, the painting is done by brush and allowed to 'airdry' and not in an oven as usual.

B-5. Also, certain makes of meters which have name plates permanently fixed to the cover cannot be painted by either dipping or spraying process and hence are painted by brush and dried in the oven. Bases and covers are then sent back to the repair section.

APPENDIX C

(*Clause* 12.3.3.6)

SPECIFICATION FOR LUBRICATING OIL

C-1. GENERAL

C-1.1 This specification covers the requirements of the lubricating oil used for top bearing, lower bearing and register of watthour meter.

C-2. MATERIAL

C-2.1 The lubricant shall be mineral oil, synthetic oil or a mixture of fatty esters and synthetic oils chemical (composition of a suitable oil is 'alkyl naphthenic acid alkanal ester').

C-2.2 The lubricant shall be free from moisture and sediments.

C-2.3 The lubricant shall not deposit any solid matters and not be decomposed at a temperature over the solidifying point.

C-3. PROPERTIES

Reaction	Neutral
Specific gravity, 15/4°C	0·905 0
Flash point, °C	211
Viscosity, Cst. @ 30°C	36·46
@ 100°F	26·46
@ 210°F	5·06
Viscosity index	134
Pour point	−37·5
Volatile matter, percentage weight 98	0·04
Colour, union	1½ (—)
Total acid value, mg. KOH/g	0·20
Corrosion copper strip, 100 C × 3 h	la
Friction factor	0·13
Rust preservative humidity cabinet, h	24 *Min*
Thermal stability, 140°C × 6 h	Pass

C-4. CORROSION TEST (ROUTINE)

C-4.1 Dip the test pieces of 15 × 25 mm brass plate or copper plate in the lubricant and heat them up in boiling water for five hours. There shall be no change of colour of the test pieces.

C-5. PACKING AND MARKING

C-5.1 The lubricant shall be suitably packed in a well closed container of 1 litre capacity of standard practice and shall be marked with the following:

a) Name of the material,

b) Name of the manufacturer,

c) Volume of the meterial, and

d) Date of manufacture.

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